Chapter 1 Introduction

1.1 Purpose of the Freeway Management System Design Guideline

The Intermodal Transportation Division (ITD) of the Arizona Department of Transportation (ADOT) carries out the responsibilities legislated to ADOT by its governing body, the seven-member Arizona State Transportation Board. The ITD is composed of 11 groups and 10 engineering districts. The Division is directed by the state engineer and three deputy state engineers.

The Transportation Technology Group (TTG), one of the 11 groups within ITD, is responsible for deploying technology to improve ground transportation in Arizona, traditionally called Intelligent Transportation Systems (ITS). ITS deployments on urban highways in Arizona are called the Freeway Management System (FMS). This guideline is published by the TTG to support the design of Freeway Management System technology and infrastructure.

This set of guidelines is targeted to assist designers to incorporate the basic elements of the FMS in their Plans, Specifications, and Engineer's Estimate (PSE) documents, and to facilitate the ongoing implementation of the FMS. The FMS consists of communications, electronics, and information processing to enhance safety, capacity, and emergency response.

This guideline document is neither a standard nor substitute for engineering experience, skill, knowledge, or judgment. Actual conditions require the use of engineering judgment in using the direction contained in this guideline.

The term *designer* refers to anyone, regardless of title and employer, who prepares plans, specifications, and estimates (PS&E) for FMS projects in the state of Arizona. Where the term *Contractor* is mentioned in this guide, it is understood that the role of Contractor is to be viewed from the designer's perspective. The Contractor physically constructs the system. This document is not a substitute for formal documents binding to a Contractor.

FMS projects typically require a planning document, such as

- Project Assessment (PA),
- FMS Concept Report, or,
- If part of a roadway project, a chapter within the Design Concept Report (DCR).

Most projects also require a formal DQMP (Design Quality Management Plan).

The ADOT TTG project manager (PM) reviews all FMS planning and design documents during various stages of design. The designer will consult with various other sections/groups within ADOT during the design process, including:

- Roadway Engineering Group – to incorporate FMS fully into the civil design
- Roadway Pre-Design

- Roadway Design
- Drainage Design
- Roadside Development
- Valley or Statewide Project Management – to assure compatibility of the FMS with the civil design
- Federal Highway Administration - for oversight
- The regional ADOT District – to assure compatibility of the FMS with regional ADOT goals
- Contracts & Specifications (C&S) - for guidance in writing special provisions
- Others (including Environmental Planning Group, Bridge Group, Traffic Group, Right-of-way Group Program and Projects Management, and Utility & Railroad Engineering)

1.1.1 History of the FMS Design Guide

The first *FMS Infrastructure Design Guideline* was published in 1989. The first update was published in 1994. The *Guide* was further updated in 2000 in conjunction with the Phase 3 work in Phoenix and subsequent projects. The *Guide* was again updated in 2002 for the Phase 5 project in Phoenix and the Tucson Phase 1. The *2007 Design Guide* is the first to drop the word "Infrastructure" from the title. Three new sections were added to address other aspects of the FMS, some that fall outside the domain of infrastructure; Communication Nodes, OSP data base, and Testing. Ramp Metering was removed and a separate Design Guide was first published in 2003. Finally, the term Variable Message Sign has been changed to Dynamic Message Sign throughout the document. The State of Arizona intends to review the design guide on an annual basis.

1.1.2 FMS Goals and Objectives

The Arizona Department of Transportation (ADOT) manages an extensive FMS in the two urban areas (Phoenix and Tucson), as well as a vast array of intelligent transportation devices in rural Arizona. This guideline does not address rural Arizona devices such as Roadway Weather Information Sensors (RWIS), but focuses on urban applications.

There are two types of traffic congestion in urban areas, namely recurring and non-recurring congestion. Congestion occurs when the demand exceeds the capacity, or when capacity is reduced. Recurring congestion commonly occurs during the morning and evening commutes when traffic demand exceeds the available capacity of the freeway lanes. In addition, non-recurring congestion occurs when accidents, disabled vehicles, debris in the roadway, construction, adverse weather conditions, and other factors reduce the capacity of the freeway to below the traffic demand.

The objectives of the FMS are intended to:

- Reduce the impacts of congestion
- Minimize the duration and effects of non-recurring congestion
- Maximize the operational safety and efficiency of the traveling public
- Provide motorists with relevant traffic information
- Provide assistance to motorists

- Operate a system that provides a service and builds credibility with the public

The benefits of the FMS for the motoring public include:

- Improving safety
- Improving efficiency of the motoring public
- Reducing environmental impact
- Reducing fuel consumption
- Enhancing productivity
- Saving lives through emergency response
- Reducing secondary collisions
- Integrating regional traffic management systems
- Centralizing management of the freeway system

1.1.3 Concept of Communications

In general, ADOT FMS communication macro-level design was initially guided by the ADOT *FMS SONET*[•] *Communications Master Plan* (published in 1999). ADOT no longer uses *SONET* technology and communication equipment continues to evolve with immerging technology. In the two largest metropolitan areas in the state, ADOT facilitates the sharing of information between ADOT and local agencies by promoting regional connectivity. FMS and local Cities ITS systems facility share agreements are established through Joint Project Agreements (JPA).

Table 1.1 ADOT Regional Connectivity Networks

METRO AREA	ACRONYM	NAME
Phoenix	RCN	MAG Regional Community Network
Tucson	RTDN	PAG Regional Tucson Data Network

The network documents are available at the respective websites: MAG = http://www.mag.maricopa.gov and PAG = http://www.pagnet.org/AboutPAG .

Generally, it is ADOT's intent to provide communication redundancy for all FMS segments. This redundancy can be accomplished either physically within the segment through a dual trunkline system or technologically through the use of an alternate path, such as via an alternative looped freeway conduit path. Freeway spokes require dual trunklines, but where a continuous loop can be established and the communication equipment can travel the distance, the trunkline is constructed on one-side of the freeway.

***Note**:* ADOT no longer uses the SONET standard for FMS as shown in the *FMS SONET Communication Master Plan.*

Further, the designer should be versed in communications technologies, including fiber-optics, analog FDM (Frequency Division Multiplexing), digital TDM (Time Division Multiplexing), Course Wave Division Multiplexing (CWDM) and Internet Protocol (IP) technologies. These latter technologies allow for improved redundancy opportunities and efficiencies.

1.1.4 Using this FMS Design Guide with Other Documents

The ADOT TTG is a division within the ADOT Intermodal Transportation Division (ITD). Generally, the TTG teams follow the Plans, Specifications, and Estimates (PS&E) document preparation guidelines for Roadway Engineering. The PS&E documents are to be prepared at the 60%, 95% and 100%, and seal stages (Stages III, IV, and V).

The designer shall be guided by these *2007 FMS Design Guidelines* and by the latest version of several ADOT documents, including but not necessarily limited to:

- *Pre-design Guidelines* (http://www.azdot.gov/Highways/RdwyEng/RoadwayPredesign/Index.asp)
- Design Procedures Manual
- TTG Ramp Meter Design, Operations, and Maintenance Guidelines
- FMS Standard Drawings
- FMS Standard Specifications
- *Stored Specifications (*all, with emphasis on those related to FMS)

Refer to the ADOT TTG website for the latest instructions and to find the respective documents. The designer shall also consult the ADOT TTG PM for recent FMS standards that have not yet been adopted within these published documents.

It is also helpful for the designer to understand the *ADOT TOC Operations Manual* for FMS operations. This manual offers a prospective from the actual users of the system.

The ADOT Traffic Group publishes the *Traffic Signals and Lighting Standard Drawings*. These standard drawings contain several standards that may appear to duplicate FMS standards.

1.1.5 Definitions

Table 1.2 is a list of commonly used acronyms that appear throughout this document.

Table 1.2 Acronyms

ACRONYMS	DESCRIPTION
AASHTO	American Association of State Highway and Transportation Officials
ADOT	Arizona Department of Transportation
APL	Approved Products List
ASTM	American Society for Testing and Materials
AQD	Advance Queue Detector
CCTV	Closed Circuit Television
CLSM	Controlled Low Strength Material
CWDM	Coarse Wavelength Division Multiplexing
DCR	Design Concept Report
DMS	Dynamic Message Sign
DQMP	Design Quality Management Plan
FDM	Frequency Division Multiplexing
FMS	Freeway Management System
GIS	Geographic Information System
HDD	Horizontal Directional Drilling
HDPE	High Density Polyethylene
HVAC	Heating, Ventilation, and Air Conditioning
IMSA	International Municipal Signal Association
IP	Internet Protocol
HDD	Horizontal Directional Drilling
HDPE	High Density Polyethylene
HVAC	Heating, Ventilation, and Air Conditioning
IMSA	International Municipal Signal Association
IP	Internet Protocol
ITD	ADOT Intermodal Transportation Division (which includes TTG)
ITS	Intelligent Transportation Systems
LED	Light Emitting Diode
MAG	Maricopa Association of Governments
MUTCD	Manual on Uniform Traffic Control Devices

ACRONYMS	DESCRIPTION
NEC	National Electric Code
Node	Communications hub for termination of trunk line fiber optic cables, typically housed inside a climate controlled secure building at a SI (system interchange).
NTCIP	National Transportation Communication for ITS Protocol
OSP	Outside Plant
PA	Project Assessment
PAD	Passive Acoustic Detector
PAG	Pima Association of Governments
PM	Project Manager
PRIDE	Product Resource Investment Deployment and Evaluation
PS & E	Plans, Specifications and Estimates
PVC	Polyvinyl Chloride
RCN	(MAG Phoenix Metro) Regional Connectivity Report
RMC	Rigid Metal Conduit
RTDN	(PAG Tucson Metro) Regional Tucson Data Network
SDR	Size Diameter Ratio
SI	System Interchange (Freeway to Freeway)
SMFO	Single-Mode Fiber-optic
TDM	Time Division Multiplexing
TI	Traffic Interchange (Crossroad)
TOC	Traffic Operations Center(s)
TTG	Transportation Technology Group
UPS	Uninterruptible Power Supply
VAC	Volts – Alternating Current
VDC	Volts – Direct Current